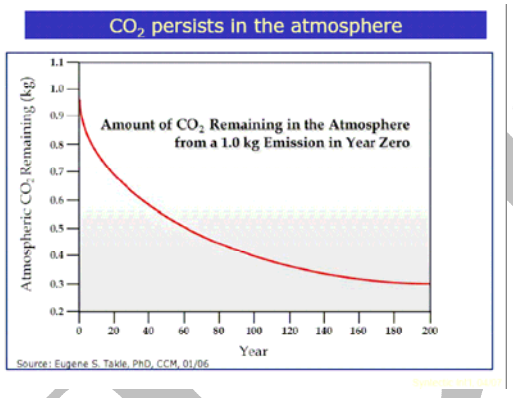
ADAPTING TO A CHANGING CLIMATE IN NEW HAMPSHIRE

Overview

Throughout the next century climate change is expected to have significant effects on important economic, health and natural resource sectors across the Granite State. It is a key premise of this Chapter that climate will continue to change even if emissions of greenhouse gases are drastically reduced. This is because the interdependent physical, chemical and biological processes in the oceans, atmosphere, and on land do not respond instantly to changes in greenhouse gas emissions and because those greenhouse gases have mean residence times in the atmosphere of decades to over a century.



Mitigation, that is reducing carbon emissions, should not be the only preventive action in our state's response to climate change, adaptation actions and responses should be evaluated and where necessary, implemented. The projections of impacts provided in this chapter provide a frame of reference to evaluate appropriate climate change response.

As a state, we face two types of risks:

1) Risk from climate change impacts; and
2) Risk of incorrect commitment of, and therefore, wasted resources

What is Adaptation?

While emission reduction strategies are intended to reduce climate change by limiting the build-up of greenhouse gases in the atmosphere, adaptation strategies are actions to reduce vulnerability to climate change, cope with its impacts, or take advantage of its potentially beneficial consequences.

Adaptation can mean enacting measures to *INCREASE NATURAL RESILIENCE* in species and ecosystems so they can recover more quickly from climate disturbances or adjust to new patterns of climate variability and climate extremes.[1]. It can also mean taking proactive steps to *FACILITATE ADAPTIVE RESPONSES* to help human communities and ecosystems survive under new conditions or move to new locations where they can survive.[2] Or it can mean attempting to *BUILD RESISTANCE* to climate change by helping human communities and ecosystems fend off impacts in order to protect valued resources in their present locations or conditions.[3] Different strategies will make sense in different situations. In some cases, the best approach will be to employ multiple strategies simultaneously.

Major Economic Impacts

Waiting to act until climate change occurs can be more costly than making forward-looking responses that anticipate climate change, especially with respect to long-lived assets and infrastructure such as bridges and dams, coastal development, and floodplain development. A "wait and see" approach would be particularly unsuccessful in coping with:

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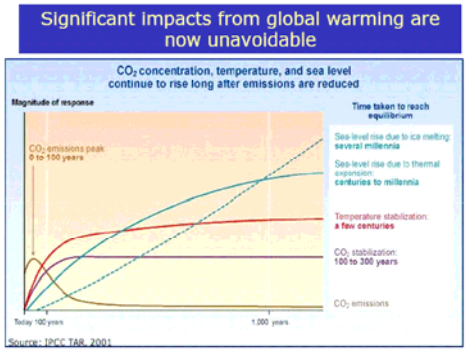
- Irreversible impacts, such as species extinction or unrecoverable ecosystem changes;
- Unacceptably high costs and damages, such as inappropriate coastal zone development that exposes lives and property to intense storm damages; and
- Long-lived investments and infrastructure that may be costly or prohibitive to change in response to climate change



Climate change resulting from increased greenhouse gas concentrations has the potential to harm societies and ecosystems. In particular, agriculture, forestry, water resources, human health, coastal settlements, and natural ecosystems will need to adapt to a changing climate or face diminished functions.[4]

If we don't act, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year, now and forever. (Stern Review July 2005)

ACTION RECOMMENDATION:
Development and Distribution of Critical Information. Invest in the analysis and dissemination of accurate and understandable information about the economic, environmental, and social impacts of climate change to decision makers.

ACTION RECOMMENDATION:
Strengthen the NH economy for adaptability to Climate Change. Policies should be created to support economic development which reduce and/or mitigate greenhouse gas emissions; mainstream climate considerations into the economic growth model and attract climate friendly employers.

Human Health

Human health has the greatest sensitivity to climate change with regard to heat stress; the effects of storms that generate floods and high winds; air pollution effects particularly as they exacerbate asthma and other respiratory effects; and diseases caused by pathogens.

Many diseases and health problems that may be exacerbated by climate change can be effectively prevented with adequate financial and human public health resources, including training, surveillance and emergency response, and prevention and control programs. Infectious diseases, especially vector-borne – such as EEE and West Nile virus are already targets of intense public health monitoring and surveillance, more is needed to understand the role climate change will play in the spread of these diseases.

Thermal stress/heat waves – Humans are susceptible to high temperatures, and heat waves are a major public health threat. Average temperatures across the Northeast have risen more than 1.5 degrees Fahrenheit (ºF) since 1970 and 4ºF between 1970 and 2000. Under a higher-emissions scenario, the Concord/Manchester area could experience nearly 70 days of 90 degree weather.[5] Elderly, and very young populations, pregnant women, and the

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chronically ill are particularly vulnerable. Some, but not all, of these increased risks can be reduced by air conditioning and other adaptation measures.

Degradation of air quality – air quality is adversely affected by higher temperatures, causing increases in both ozone levels and particulates. Poor air quality has direct impacts on respiratory and cardiac function. Releases of air pollutants that cause ozone to be formed have been declining, but would have to be reduced much more to avoid a reversal in progress toward achieving air quality standards.

Extreme weather events affecting public safety such as coastal inundation and flooding create direct hazards to humans who are living or traveling in harms way. Flooding can spread toxins and negatively impact water resources, local septic systems, and combined sewer overflows, each of which can affect public health.

ACTION RECOMMENDATION:
Focus Policies and Actions To Help At Risk Populations Prepare for Impacts of Climate Change. Public health agencies need to continue to identify individuals at risk and work with the Department of Environmental Services in the areas of health related impacts and public outreach.

ACTION RECOMMENDATION:
Charge and Empower Public Health Officials to Prepare for the Public Health Impacts of Climate Change. Public health officials need better data/analysis for vector-borne infectious disease forecasting.

Agriculture and Forestry

New Hampshire agriculture produced approximately $930 million in direct spending, supporting 11,600 jobs in FY02.[6] Insect population increases. Tree species composition are likely to change as species respond to a changing climate. The climate models project decreases in the number of frost days, where temperatures dip below freezing, and increases in the length of the frost-free growing seasons. We must consider the effectiveness of strategies that:

- Alter the timing of planting dates to adapt to changing growing conditions
- Maint agricultural lands to grow food locally
- Altercropping mix and forest species that are better suited to the changing climatic conditions
- Breed new plant species and crops that are more tolerant to changed climate condition
- Promote fire suppression practices in the event of increased fire risk due to temperature increases

Coastal Areas and Sea Level Rise

Sea level rose at an average rate of 2-2.7 mm per year in New Hampshire over the last century, which equates to nearly a foot per century.[7] Sea-level rise is likely to accelerate, inundating hundreds of square miles of wetlands and land. The

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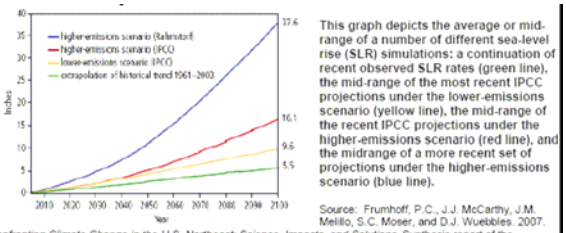
United Nations Intergovernmental Panel on Climate Change (IPCC) projects that global sea levels will rise between 7 and 14 inches under a lower-emissions scenario and between 10 and 23 inches under a higher-emissions scenario over the next century.



This graph depicts the average or mid-range of a number of different sea-level rise (SLR) simulations: a continuation of recent observed SLR rates (green line), the mid-range of the most recent IPCC projections under the lower-emissions scenario (yellow line), the mid-range of the recent IPCC projections under the higher-emissions scenario (red line), and the midrange of a more recent set of projections under the higher-emissions scenario (blue line).

Source: Frumhoff, P.C., J.J. McCarthy, J.M. Melillo, S.C. Moser, and D.J. Wuebbles. 2007. *Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions.* Synthesis report of the Northeast Climate Impacts Assessment (NECIA). Cambridge, MA: Union of Concerned Scientists (UCS).

The result of this magnitude of sea-level rise is that the return recurrence interval of today's 100-year storm surge will drop to between 2 and 15 years.

Coastal flooding is a combination of riverine flooding from precipitation and storm surge. As such, it is extremely difficult to predict the occurrence of coastal flooding. Much more work is needed to develop better prediction tools for coastal flooding and to better characterize coastal flow patterns. Currently, the best data available gives us 5 foot contours of some areas in the state's coastal watershed, however those contours do not include Great Bay which with over 200 miles of tidal shoreline, dwarfs in comparison with New Hampshire's 18 mile open-ocean shoreline.

- Analyzing the environmental consequences of shore protection
- Promoting shore protection techniques that do not destroy all habitat
- Identifying land use measures to ensure that wetlands migrate as sea level rises in some areas
- Engaging state and local governments in defining responses to sea level rise

Ecosystems and Wildlife

The implications of climate change are more dire for natural systems, because it will be difficult for many species to change their behavior or migrate in response to climate change. Many of the state's species are currently stressed by a variety of factors including land-use changes, pollution, invasive species, and fragmented (or isolated) habitats. Such conditions, coupled with the relatively rapid rate of anticipated climate change, are likely to challenge many species' resiliency and chances for successful adaptation.[8]

In unmanaged natural systems, adaptation is autonomous and reactive, which means it is not planned but occurs when forced to do so. For example, as the climate warms, tree and animal species may migrate northward to remain in suitable climatic conditions and habitat (to the extent that human barriers, such as roads and cities, allow such migration).

The key to fostering resilient natural systems is to maintain overall ecosystem health and to conserve important areas. Conservation strategies must be implemented at large scales and with awareness that natural systems may already be changing in undetected yet significant ways. Effective conservation in the face of a rapidly changing climate requires us to think not only about where plants, animals and natural communities are currently found, but where they might be found in the future. Developing such adaptation strategies is not a simple, one-time exercise; instead it is a process that builds on itself continuously. (Niang-Diop and Bosch)

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Higher peak flows and degraded streams would transmit more nutrients and sediments to the Great Bay estuary and its tidal tributaries, contributing to water quality impairment in the estuaries.

There are a variety of non-climatic stresses that affect natural systems, including pollution, habitat fragmentation, habitat conversion, unsustainable levels of resource extraction and invasive species. When these stresses interact synergistically with climate stresses—and frequently they do—the results are greater overall impacts.[9] For example, when rainbow trout are exposed to pesticides, the impact grows worse as water temperature increases.

Today, fragmentation of natural systems by roads, infrastructure and other alterations has created obstacles to migration. Adding corridors between protected areas or "stepping stones" of reserve networks across latitudinal and altitudinal gradients will help ensure that species can continue to move toward their optimal climatic zones. It is also important to protect multiple examples of different habitat types to guard against risks that some sites may be irretrievably altered by:

- Encouraging appropriate growth in existing urban areas and protect natural areas and;
- Continuing the development of a system of intact protected areas to foster resiliency and protect ground water
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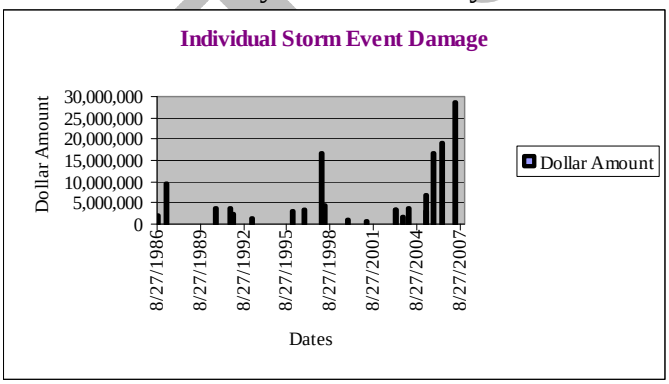
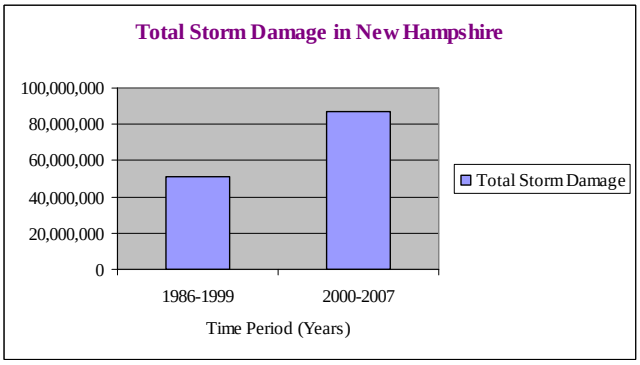
ACTION RECOMMENDATION:
Strengthen the Protection of New Hampshire's Natural Systems. Encourage growth in developed areas and protect natural areas with a greater emphasis on regional development strategies.

Infrastructure

New Hampshire has more than 16,000 miles of rivers and streams and the state's settlement pattern is confluent with these locations. Floodplains are extensions of the watercourses and have evolved to carry runoff naturally. Over the past three years, New Hampshire has experienced three - 100 year flood events, with just one of these events costing the state $35 million.





Infrastructure systems are among the most critical, particularly for urban areas in the state, even modest disruptions can have significant impacts on daily life. Potential

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disruptions include alteration to the hydrological regime resulting in pressure on stormwater systems – to be able to handle large volumes of water in short time.

Expected that precipitation intensity is likely to increase by ___ . Municipal water utilities have generally not integrated climate change impacts into stormwater planning and drainage infrastructure. Stormwater impacts and management already carry significant economic costs for municipalities.

- Create retreat policy for coastal and floodplain properties;
- Guide future development away from flood prone areas and maintain adequate setbacks

ACTION RECOMMENDATION:
Increase Resilience to Extreme Weather Events. Given that climate change forecasts for drought punctuated by extreme precipitation events and higher sea levels, our built environment may be at increased risk in inland flood prone areas and the seacoast. Mechanisms to protect against such risks should focus on municipal ordinances, building codes, land use practices, infrastructure planning, and incentives.

County	NFIP Policies	Insurance In Force	Total Paid Losses	*Total Paid Amount*	*Total Repetitive Loss Properties*
Belknap	260	$42,551,800	90	$666,514	12
Carroll	457	$77,004,300	203	$767,642	8
Cheshire	530	$93,334,400	175	$4,418,672	0
Coos	179	$20,371,400	64	$358,739	4
Grafton	812	$116,738,400	190	$1,288,192	19
Hillsborough	1,036	$209,678,200	508	$5,365,100	19
Merrimack	455	$88,151,400	245	$2,740,269	18
Rockingham	3,501	$559,885,600	1,513	$11,175,810	96
Strafford	322	$69,931,300	105	$977,142	2
Sullivan	145	$22,436,400	33	$244,446	1
Total	7,697	$1,294,083,200	3,126	$28,002,526	179

Source: FEMA (June 29, 2007)

"Repetitive Loss" means flood-related damage sustained by a structure on two separate occasions during a 10-year period for which the cost of repairs at the time of each such flood event, on the average, equals or exceeds 25 percent of the market value of the structure before the damage occurred.

Better Understanding the Risks

Adaptation planning continues to involve many uncertainties It is clear that traditional approaches to adaptation will not suffice in a future that no longer resembles the past. Climate models can be downscaled to incorporate locally important phenomena, such as urban heat island and forest cover effects, and resolve important geographical differences from climate change impacts. All levels of government must have transparent planning procedures that are fully integrated with other aspects of their work, and they must be sure that their long-term commitments not only allow for, but encourage adaptive management in an effort to establish a "no regrets" strategy for New Hampshire to adapt to climate change.

ACTION RECOMMENDATION:
Permanently Establish a Climate Change Advisory Council. A Climate Change Advisory Council should be engaged to charge public and private partners and state agencies to plan for episodic and chronic events that result from climate change.

[1] IPCC, 2007: Summary for Policymakers. In: Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani ,J.P. Palutikof, P.J. van der

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Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 7-22

[2] Id.

[3] Millar, C., 2007. Climate Change and Forests of the Future: Managing in the Face of Uncertainty. *Ecological Applications*. 17(8).

[4] "Coping with Climate Change: The Role of Adaptation in the United States," Pew Center on Global Climate Change, June 2004.

[5] Confronting Climate Change in the U.S. Northeast: Science, Impacts, and Solutions (NECIA, 2007).

[6] New Hampshire Department of Agriculture.

[7] New Hampshire Hazard Mitigation Plan, 2007.

[8] "Coping with Climate Change: The Role of Adaptation in the United States," Pew Center on Global Climate Change, June 2004, p. 8

[9] Increasing Resistance and Resilience of Tropical Marine Ecosystems to Climate Change. From: Hansen, L.; L. Biringer; and J. Hoffman, 2003. Buying Time: A User's Manual for Building Resistance and Resilience to Climate Change in Natural Systems. World Wildlife Fund, Washington, DC.

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